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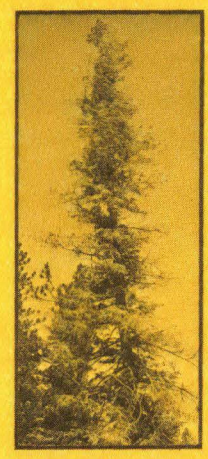

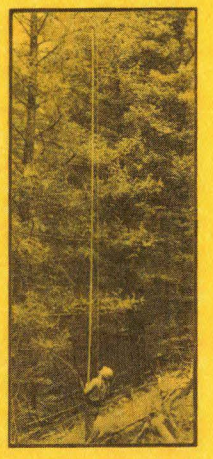

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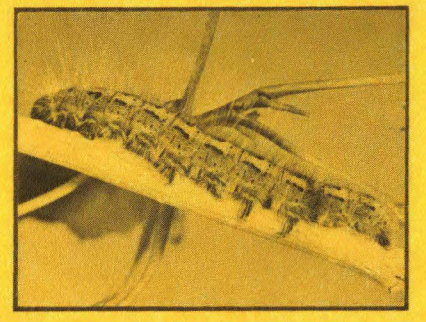

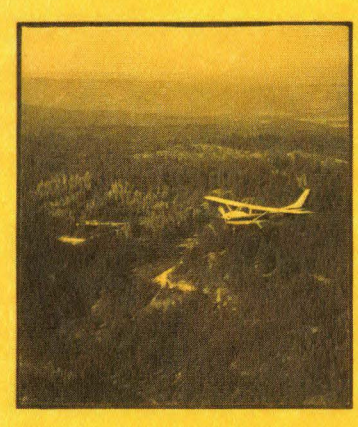

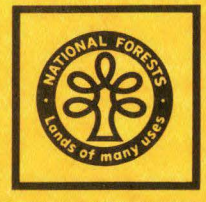

Branch of Forest Insect and Disease Prevention
and Control
Division of Timber Management
U.S. Forest Service
Ogden, Utah

February 1974

by

William H. Klein

EVALUATING A MOUNTAIN PINE BEETLE INFESTATION WITH THE AID OF 35 MM AERIAL PHOTOGRAPHY

Report No. 2

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EVALUATING A MOUNTAIN PINE BEETLE INFESTATION WITH THE AID OF 35 MM AERIAL PHOTOGRAPHY

Report No. 2

INTRODUCTION

This is the second in a series of continuing reports describing the methods and results of a 35 mm aerial photograph evaluation survey. The survey was designed to measure the yearly trend of a mountain pine beetle epidemic in a high elevation stand on the Targhee National Forest, Idaho. The initial survey was undertaken during 1972 and reported in January 1973 (Klein, 1973).

Some details characteristic to this survey will be discussed, but for general information on methodology, types of equipment used, and certain operational procedures, refer to the above mentioned report.

The initial survey and previous work with 35 mm aerial photography showed that the method could be used operationally for detecting and quantifying bark beetle killed trees the year following attack. The main conclusions from the 1972 survey were that the 1971 infestation was at a relatively low level (0.66 trees per acre), and that a high potential for increase was indicated for 1972.

PURPOSE

The purpose of this survey was to detect and quantify the level of tree killing in 1972 and to compare it with the 1971 level. In addition, an attempt was made to estimate the 1973 infestation level by recording all of the newly attacked trees during the ground truth survey.

AREA

The photo survey area, approximately 25,000 acres in size, is on the Moose Creek Plateau, Targhee National Forest, and covers essentially the area photographed during the 1972 survey (Figure 1). Part of the southeast corner of the 1972 survey

area was omitted during the 1973 flight because of heavy cloud cover. However, there was still more than sufficient overlap of the two surveys to make them comparable.

METHODS

Photography was taken on August 20 between 10:30 a.m. and 12:30 p.m. (MST). The camera was a Nikon F with an 85 mm auto Nikkor lens and a Nikkor LIA filter. Film was Kodacolor-X in standard 36 exposure cassettes. Shutter speed was maintained at 1/500 second while lens aperture varied from f 4 to f 5.6 to compensate for ground shadows caused by scattered, high (4,000-5,000 ft. above mean datum) cumulus clouds.

Five parallel flight lines, one mile apart, were flown in a north-south direction at a mean elevation of 3,000 feet above average datum for a scale of 1:3,300. Forty-four sets of stereo triplets (plots) were obtained within the survey area (Figure 1). As the survey progressed, cloud cover increased, became progressively lower, and eventually covered the southwest corner of the survey area.

Film was processed by Eastman Kodak and printed in a standard 3R (3 x 5) format. A square 4-acre plot was delimited in the center of the effective area of the best stereo pair of each triplet. Counts of all 1972 attacks (1973 faders) were made by an experienced photo interpreter with a pocket stereoscope.

Nine (20 percent) of the 44 plots were selected for ground checking to obtain a correlation between photo counts and ground truth. Factors used in the selection of ground samples were ease of accessibility, distribution over the entire area, and a minimum of at least two faders per plot. All plots were located on resource photography and later transferred to a field map.

The ground survey was conducted by a two-man crew during the period September 18-21. Plot corners and boundaries were located, marked with string lines and all recent mountain pine beetle-killed trees were located, examined, and classified as (1) an old attack (1971 and before); (2) a 1972 attack (1973 fader) or (3) a new (1973) attack. All 1973 faders were mapped and located on the photos (Figures 2 and 3).

As a check on scale determination, at least one side of each ground truth plot was measured using a topographic tape and relaskop.

RESULTS AND OBSERVATIONS

There was relatively good agreement between the photo and ground subsamples (r = 0.91), although the correlation was not as high as last year's (r = 0.97). The comparison shows that 83 percent of the variance of photo counts was associated with ground truth (Figure 4). The adjustment of the total photo sample by linear regression follows:

1. Mean tree count on all 44 plots:
   $\bar{x}_1$ = 7.29 trees per plot
2. Mean tree count on nine plot photo subsample:
   $\bar{x}_2$ = 10 trees per plot
3. Mean tree count on nine plot field subsample:
   $\bar{y}_2$ = 11.11 trees per plot
4. Mean plot size:
   planned = 4.00 acres
   actual = 3.19 acres
5. Regression equation:
   $Y = a + bX = 2.11 + 0.88X$
6. Adjusted mean tree count:
   yrd. = $\bar{y}_2 + b(\bar{x}_1 + \bar{x}_2)$=8.73 trees per plot
7. Trees per acre (corrected for scale):
   2.74 trees per acre

Actual measurements of plot boundaries showed an increase in scale. Actual plot size varied from 2.50 acres to 3.75 acres and averaged 3.19 acres, a 20% reduction from the intended 4.00 acres.

The final 1972 infestation level was 2.74 trees per acre, slightly more than a four fold increase over the 0.66 trees per acre reported last year for 1971 attacks. A total of sixty-four 1973 infested trees were detected on the nine ground truth plots resulting in an attack density of 2.23 trees per acre. Although this was a very low intensity sample, its reliability is questionable and will be checked by the 1974 photographic survey. A summary of the three-year trend pattern on the Moose Creek Plateau follows:

Year	No. of Trees Per Acre	Method
1971	0.66	49 photo plots
1972	2.74	44 photo plots
1973	2.23	9 ground truth plots
TOTAL	5.63	

Other trend studies (Parker, 1973) (Stipe, 1973) (Cole and Amman, 1969) have shown that during the epidemic cycle of the mountain pine beetle in lodgepole pine, most of the large diameter trees are killed during the early years of the outbreak, while more small diameter trees are killed during the waning years. A key factor in determining the status of an outbreak may be the diameter distribution of trees under attack at a particular time. The diameter distribution of infested trees as recorded on ground truth plots for the years 1971, 1972 and 1973 is shown in Figure 5. The average weighted diameters of trees killed during the three years were: 1971, 12.5 inches d.b.h.; 1972, 14.7 inches d.b.h.; and 1973, 15.0 inches d.b.h.

CONCLUSIONS

Conditions at this time indicate that the infestation on the Moose Creek Plateau may be coming to a premature end and result in considerably fewer tree losses than anticipated earlier. In an area of considerably lower elevation (6,400) in the southwest corner of Yellowstone National Park the epidemic lasted seven years with peak tree killing of 27 trees per acre occurring the fourth year (Parker, 1973). In the photographic area which ranges in elevation from 7,000 to more than 8,000 feet, peak tree killing will certainly be considerably less and may already have occurred. Amman, et. al. (1973) has shown that mortality of lodgepole pine by the mountain pine beetle varies inversely with elevation. During a trend study in a high elevation stand (9,200 feet) on the Bridger-Teton National Forest, Stipe (1973) recorded a loss of seven trees per acre in the peak year.

There remains the possibility, however, that the current setback may be temporary and that a higher rate of tree killing may yet occur. The winter of 1972-73 throughout southeast Idaho was unseasonably cold and may have caused above normal mortality of the overwintering beetle population. During epidemics in other areas, the broods that were produced during

the peak and waning years progressively selected smaller diameter trees. In this instance, however, the 1971 generation of beetles were reared in smaller trees and the 1972 generation moved into larger trees. Their progeny, although probably lower in number, have continued to attack the larger diameter trees. What these conflicting factors mean in the course of this epidemic is unknown at this time. The actual long term trend of the infestation can only be determined by repeated, annual sampling.

REFERENCES

Amman, Gene D., Bruce H. Baker, and Lawrence E. Stipe. 1973. Lodgepole pine losses to mountain pine beetle related to elevation. USDA Forest Service Res. Note. INT-171, 7p.

Cole, W.E., and G.D. Amman. 1969. Mountain pine beetle infestations in relation to lodgepole pine diameters. USDA Forest Serv. Res. Note INT-95, 7p.

Klein, William H. 1973. Evaluating a mountain pine beetle infestation with the aid of 35 mm aerial photography. USDA Forest Serv., Region 4. Div. Timber Management, Ogden, Utah, 7p., illus.

Parker, Douglas L. 1973. Trend of a mountain pine beetle outbreak. J. Forestry 71(11):668-670.

Stipe, Lawrence E. 1973. Mountain pine beetle trend and impact study near spring creek park, Bridger National Forest. USDA Forest Service., Region 4, Div. Timber Management, Ogden, Utah, 2p.

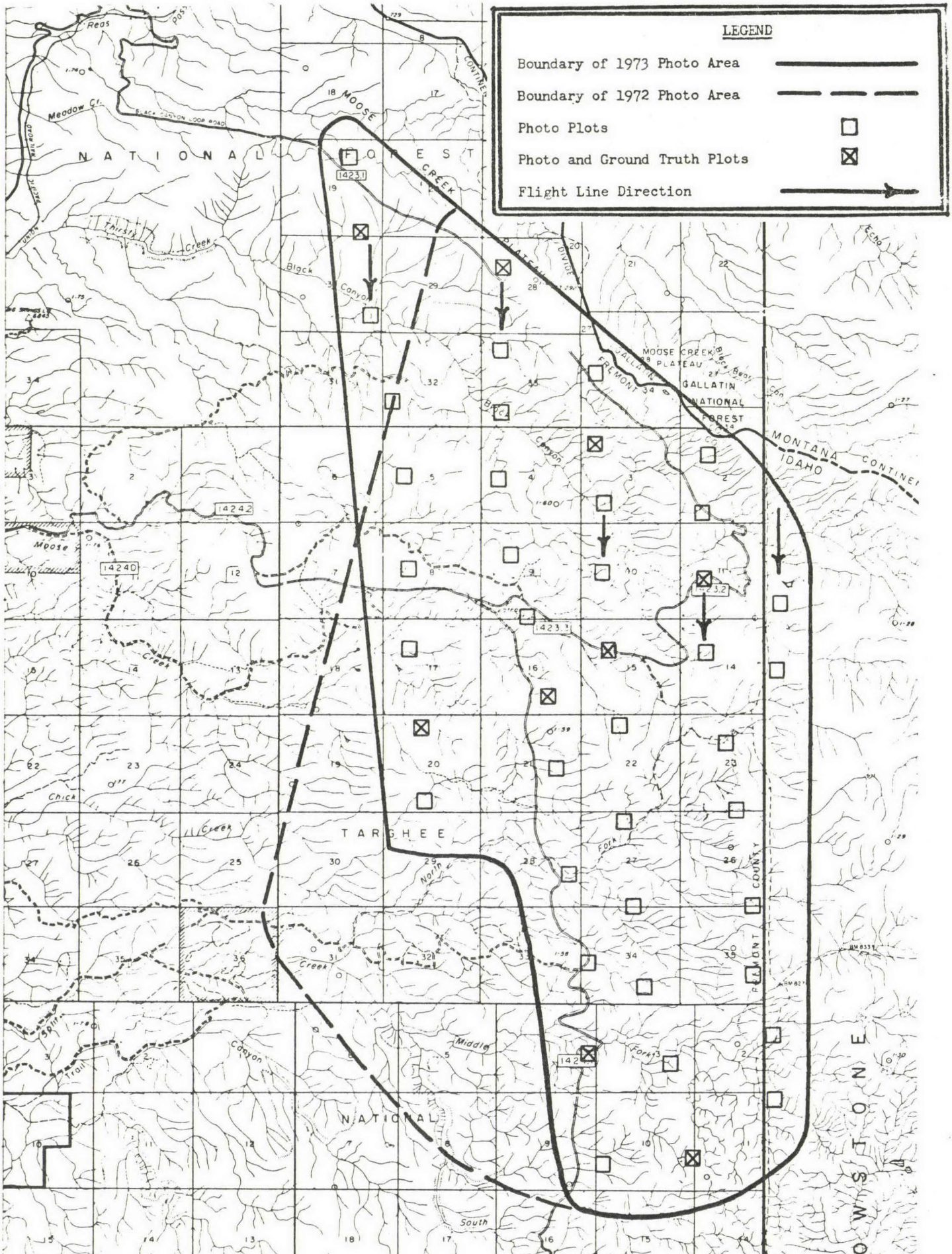

Figure 1. Moose Creek Plateau and adjacent area showing the areas covered by the 1972 and 1973 aerial photographic surveys.

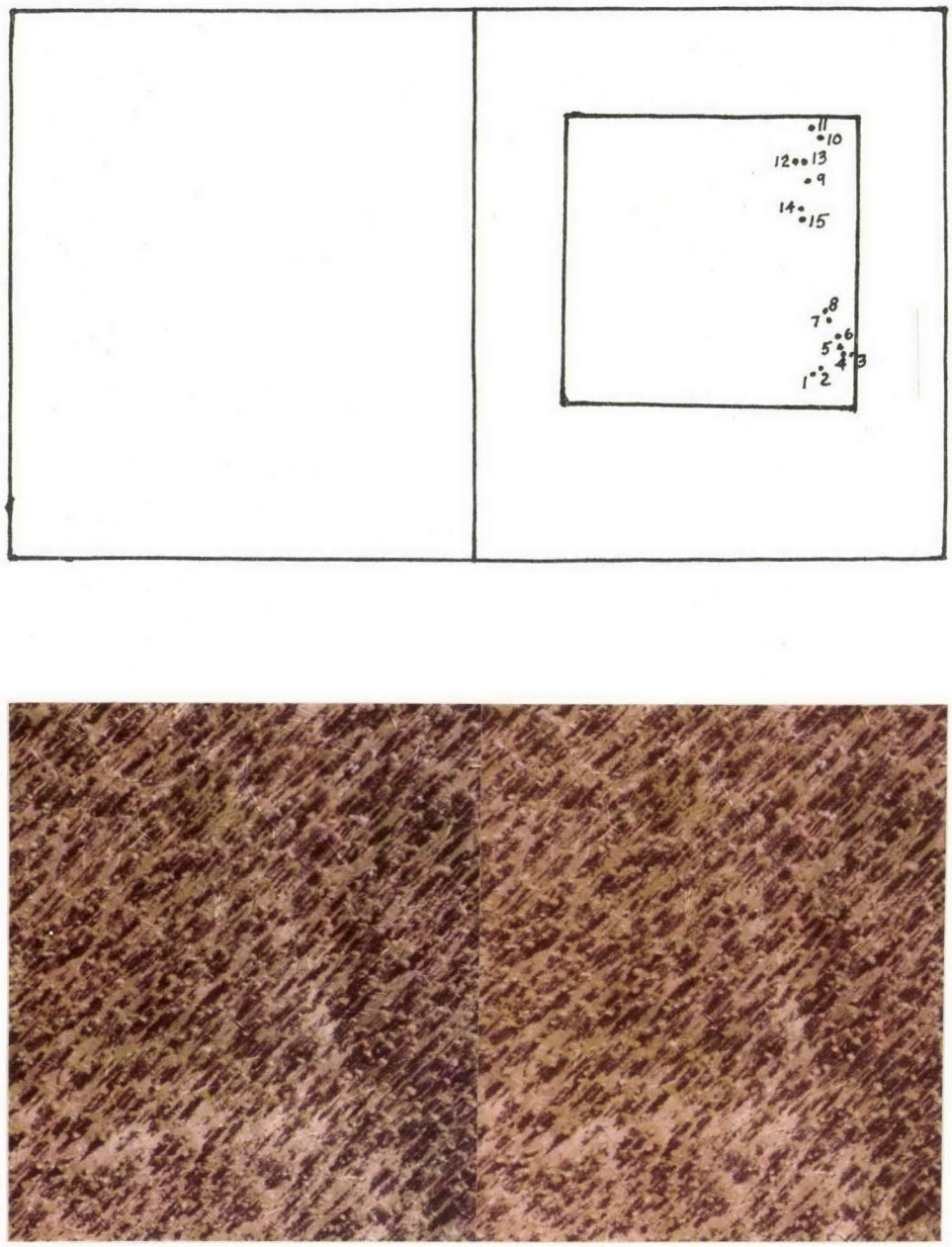

Figure 2. Stereogram of plot 3-25 showing fifteen 1972 mountain pine beetle killed lodgepole pines (1973 faders). Area of plot is 3.12 acres. Note incidence of dead tops.

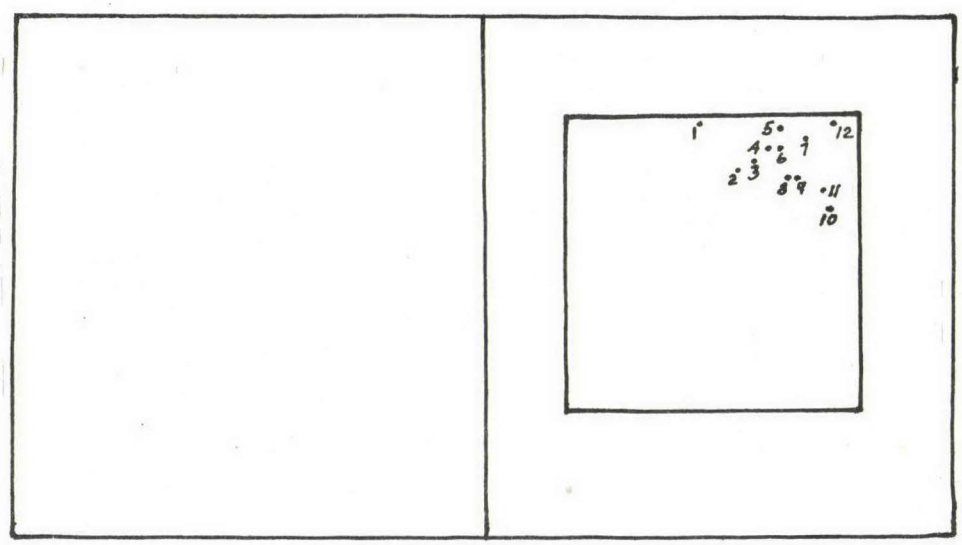

Figure 3. Stereogram of plot 5-48 showing twelve 1972 mountain pine beetle killed lodgepole pines (1973 faders). Area of plot is 2.79 acres. Note the incidence of dead tops.

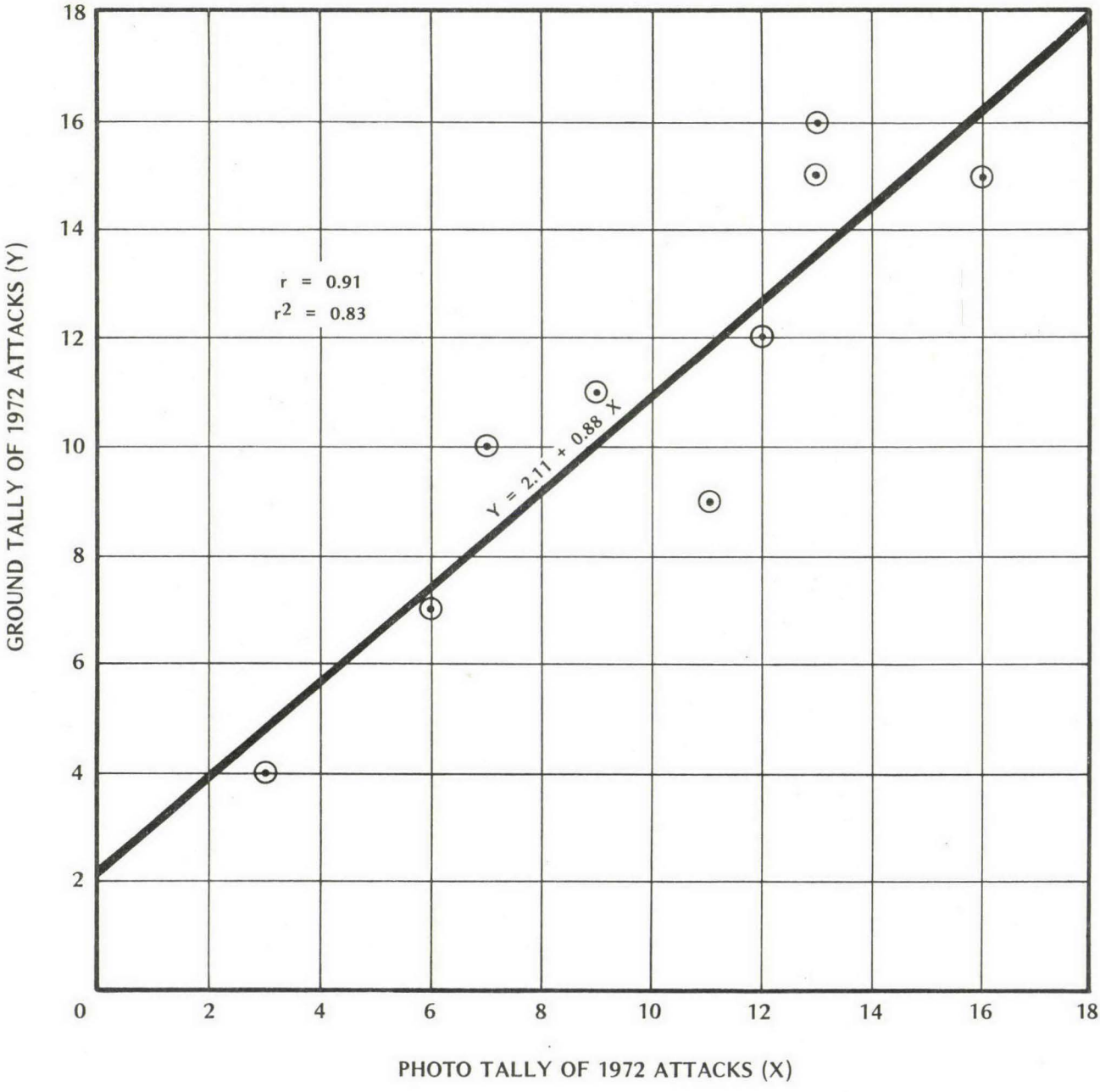

Figure 4. Comparison of photo-to-ground counts of lodgepole pine killed by the mountain pine beetle--Moose Creek Plateau, Targhee National Forest.

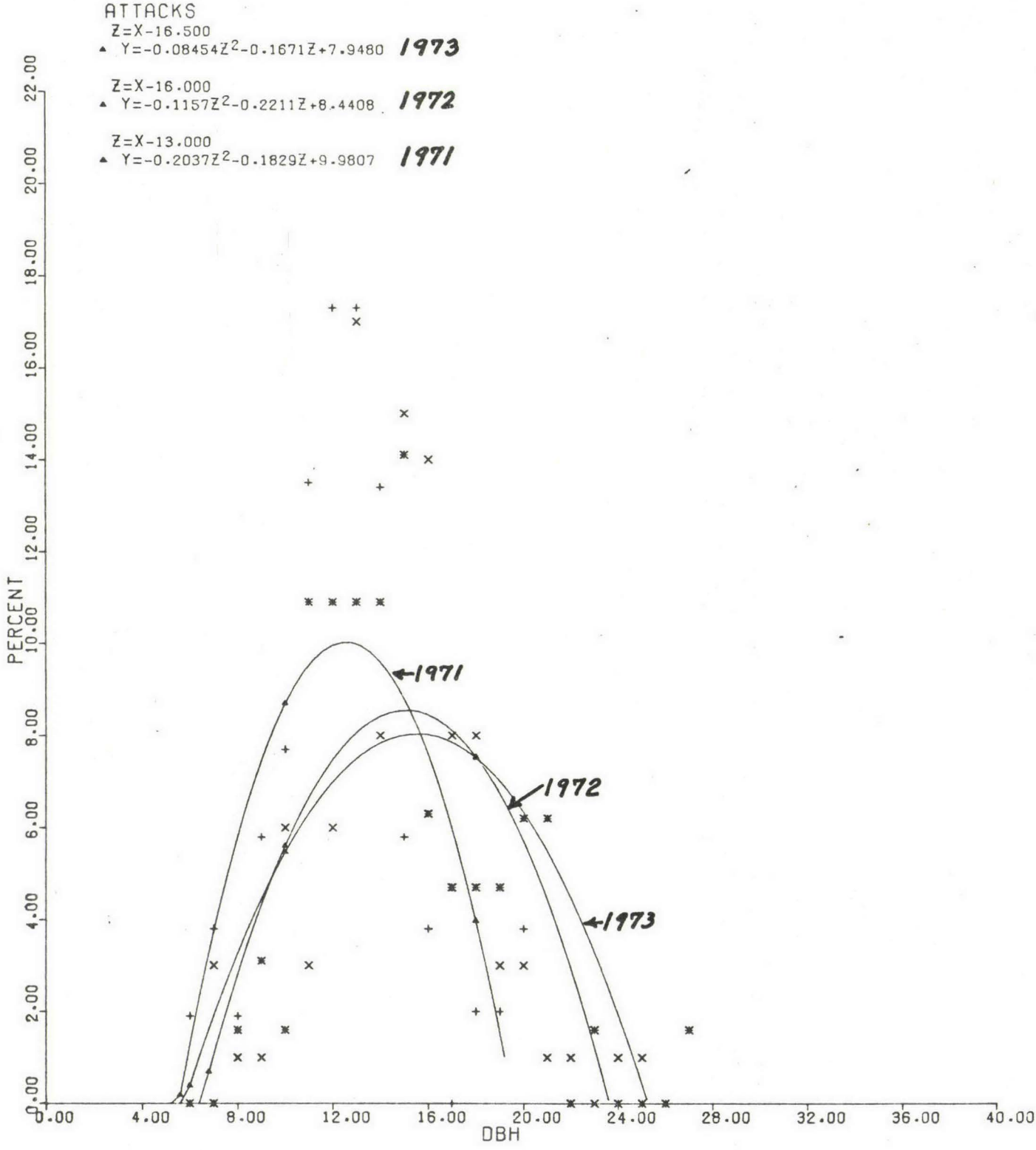

Figure 5. Computerized two-degree polynomial graph showing the diameter distribution of trees attacked by the mountain pine beetle during a three year period.